Title of Report: Pest Management Grants Final Report

Contract Number: 98-0259

Contract Title: Training Scouts & Developing Demonstration Sites to Promote Floriculture IPM Programs

Principal Investigators: Julie Newman, Steve Tjosvold, Karen Robb, Michael Parrella, Jim MacDonald, Heather Costa, Diane Ullman

Contractor Organization: University of California

Date: December 22, 2000

Prepared for California Department of Pesticide Regulation
by Julie Newman

Disclaimer.

The statements and conclusions in this report are those of the contractor and not necessarily those of the California Department of Pesticide Regulation. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

Acknowledgments.

We would like to acknowledge the following organizations who, in addition to DPR, provided funding: American Floral Endowment, Hansen Trust, Kee Kitayama Research Foundation, UC-IPM, Uniroyal, USDA, and Valent. We would also like to acknowledge technical support from Steve Martin, John Rodgers, Sarah Cain, Scott Parker, Deborah Yamashita, Chris Casey, Linda Bolkan, Carla Thomas, and Hien Nguyen, and support from all cooperating growers.

This report was submitted in fulfillment of DPR Contract #98-0259, Training Scouts and Developing Demonstration Sites to Promote Floriculture IPM Programs.

Table of Contents

List of Figures

Abstract

The major objective of this project was to increase the adoption of IPM and reduced-risk management practices in the ornamental production industry. To accomplish this goal we determined the efficacy of new materials and IPM strategies that could potentially minimize pesticide use and achieve control with the least possible harm to human health, non-target organisms, and the environment. An important objective was to demonstrate these techniques to growers, and incorporate promising techniques into scouting programs. We completed successful scouting demonstrations in 10 nurseries. IPM strategies that were incorporated with scouting included the use of reduced risk/biorational pesticides, petunia indicator plants, biological control, and directed spray programs. We evaluated reduced-risk/biological pesticides in demonstration programs and in separate experiments, identifying some effective materials. In addition, other new IPM approaches that reduce pest populations, including UV-absorbing plastic, reflective mulches and reflective plant coverings, and sticky tape was also evaluated. Of these new approaches, the most promising results were achieved with reflective plant covers. Project information was disseminated at numerous grower meetings and in publications. This project has led to an increased use of reduced- risk/biorational pesticides, lower over-all pesticide use, increased use of biological control, and increased use of petunia indicator plants.

Executive Summary

The major objective of this project is to increase the adoption of the use of IPM and reduced-risk management practices in the ornamental production industry. To accomplish this objective, a statewide IPM/reduced-risk demonstration project on ornamental crops was conducted in three ornamental production regions in California.

First we validated sampling strategies for spider mites and thrips on fresh cut roses at a commercial nursery in Nipomo. Upon validation, demonstration sites were set up at eight rose nurseries statewide. Regular monitoring and the use of reduced-risk practices, including the use of directed pesticide sprays, biological control, and reduced-risk pesticides were incorporated in IPM programs implemented at each site. Comparisons were made between the IPM treatments vs. the growers' conventional pest control practices.

A scouting program using petunia indicator plants for monitoring tospoviruses and thrips vectors was implemented on cut snapdragons, and on potted chrysanthemums, begonias, and cyclamen at two other nursery sites in Ventura and San Diego Counties.

New IPM approaches that reduce pest populations, including reduced-risk/ biorational pesticides, UV-absorbing plastic for greenhouse coverings, reflective mulches and plant covers, and sticky tape were also evaluated. Reduced-risk/biorational insecticides, miticides, and fungicides were evaluated in four commercial nurseries: an insecticide was evaluated in a Santa Paula nursery, miticides were evaluated in Carpinteria and Salinas nurseries, and fungicides were evaluated in a Salinas nursery.

UV-absorbing plastic as a greenhouse covering was evaluated at two nursery sites in San Diego and Ventura County. In addition, reflective mulches and reflective plant coverings (on field-grown cut asters) and the use of yellow sticky tape (on greenhouse gerberas) were evaluated in San Diego, Ventura, and Santa Cruz Counties.

In the demonstration project on cut roses, Conserve successfully reduced thrips populations; Floramite was effective in reducing spider mites. Floramite and Conserve were successfully integrated with biological control in greenhouse roses. However, Endeavor was not effective on the aphid species we encountered in some of the greenhouses, so a conventional pesticide (Diazinon) had to be used. Use of predator mites to control spider mites, with reduced risk pesticides for other pests except aphids in some sites, was very successful. In fact, all growers in the demonstration sites are now using our program as a standard practice. The use of predator mites was more expensive than the use of conventional pesticides. Despite the additional cost, growers preferred the use of predator mites coupled with scouting to the use of miticides. This was because registered miticides such as Avid and Sanmite used in the growers' conventional programs were not as effective, and because the biological control program resulted in increased quality, less potential hazards to workers and to the environment, and less problems with adherence to reentry requirements.

The demonstration project using petunia indicator plants was useful to cooperating growers in determining where the source of thrips vectors were originating from so that they could adjust their pest management programs accordingly.

In the evaluation of new reduced-risk pesticides, Distance was effective in reducing whiteflies in asters. Numerous reduced-risk and biorational miticides and fungicides for potential use on roses were identified.

Use of non-reflective, UV-absorbing plastic as a greenhouse cover can be effective, but efficacy was limited in passively-cooled greenhouses. Use of reflective screens may make this technology of use to growers who are primarily using passively-cooled greenhouses.

Reflective mulches and reflective plant covers were effective in reducing aphid, whitefly, and especially thrips populations. For seasonal control, reflective plant covers are most effective if they are mounted so that they can be raised as the crop matures, keeping the cover just above the canopy. Use of sticky tape reduced immature whiteflies within the plant canopy of greenhouse cut gerberas, though no differences in crop quality were observed.

Another major objective of the project was to extend the information learned from this project to nursery workers as well as owners/managers, pest control advisors and others interested in IPM programs. IPM educational programs included four insect and disease management seminars that incorporated information gleaned from the demonstration sites. Statewide tours to see demonstration sites utilizing reflective mulches, UV-absorbing plastic, reduced-risk pesticides, and biological control took place in October 1999 and June 2000. Meetings to coordinate the development of these programs were held September 1999, October 1999, and September 2000. Meetings for rose growers to extend information from the rose demonstration sites took place in February, April, and July 2000. In addition, there were numerous conference calls between the investigators to plan and coordinate educational activities.

A final objective of this project was to provide training for farm advisors on the latest monitoring and reduced-risk management techniques so that they can extend this information to clientele and work more effectively at demonstration sites. To accomplish this objective, a training meeting was held at UC Davis in July 1999 with 20 participants.

This project has led to an increased use of reduced-risk/biorational pesticides, lower over-all pesticide use, increased use of predator mites for biological control, and increased use of petunia indicator plants.

The project was originally scheduled to be completed by March 2000. We experienced some delays. The planning meeting to train advisors on new techniques and coordinate statewide protocols was delayed four months because of speaker scheduling problems. The reflective mulch portion of the project had to be repeated several times to refine the technique for implementation. The scale of the UV-absorbing plastic study exceeded the original intent (both in greenhouse plot size and length of the study), and was not as successful as anticipated.

The project is now completed and this document reports the final results. We did not have enough funding ($29,997) or time to implement all techniques into scouting programs. However, we were able to develop demonstration sites using reduced-risk pesticides, biological control, and directed sprays through supplementation with other grants, most notably by dovetailing with the DPR-sponsored Rose Pest Alliance Project.

We hope to obtain future funding to implement reflective mulches and plant coverings and use UV-absorbing plastic with reflective screens in IPM demonstration projects in the future.

Introduction

Scope and Purpose

The focus of this project was to evaluate new reduced-risk pesticides and to examine new approaches that reduce pest populations, including biological control, directed spray applications, UV-absorbing plastic for greenhouses, sticky tape, and metallic, reflective mulches and plant coverings. Demonstration sites and educational programs were used to implement successful programs into scouting programs in commercial ornamental nurseries.

Background, Assumptions, and Problems

Monitoring programs provide an early warning of insect and disease presence and locate specific sites of infestation. Data collected is used to determine types of pests, stage in the life cycle, population levels, appropriate amount and type of control action needed, timing of the application, and tolerable threshold levels. The backbone of the IPM program is the scout, the person who does the monitoring, records and summarizes the field data, and reports to the grower. Our data from an earlier DPR-funded project showed that monitoring programs could be used to produce a higher quality product for less money. More scouting demonstrations are needed to demonstrate new IPM strategies as they evolve. This will help to ensure adoption of pest management practices that are more environmentally friendly and safer for workers, consumers and the community at large.

Major pests of floriculture crops include thrips, whiteflies, leafminers, aphids, fungus gnats, worms, and mites. Currently, the western flower thrips is arguably the most economically damaging pest overall since it attacks such a wide range of ornamental crops. In addition to feeding damage, the western flower thrips is the vector of tomato spotted wilt virus and impatiens necrotic spot virus, two tospoviruses that have caused severe economic damage for many growers. These viruses also have a wide host range, affecting many ornamental and vegetable crops and associated weed species. We showed that the use of petunia indicator plants could be used to monitor for these tospoviruses in the previously funded DPR project. Further technique refinement was necessary to incorporate the use of this practice into commercial scouting programs, and was a goal of this project.

In previous scouting work we were successful in incorporating biological control into existing IPM programs. Further demonstrations of the use of biological control are necessary for large-scale use in the industry. The bent cane production system recently adopted by most California rose growers has important implications for the use of biological control on ornamentals. The bent cane system separates the flowers from the lower canopy, creating an opportunity for the integration of mite predators with chemical control. The lower canopy serves as a refuge for predators where they can be protected from pesticides directed at the flowers for thrips control. Additionally, when sprays are directed at the flower buds instead of the whole canopy, it reduces spray volume without affecting efficacy (Parrella et al. 1999).

Many new reduced-risk materials labeled for ornamental use have recently come on the market, while older pesticides that applicators have relied on face an uncertain future due to mandated safety reviews. However, in many cases, these new materials cannot be used in the same manner as conventional pesticides. Insecticide resistance is an even greater risk with many of these new materials, compared to the conventional materials, so their use must be limited on each crop. Because these materials are 'softer', they may not be as efficacious as conventional materials. This is problematic for production of aesthetic crops with low thresholds for damage. It is imperative that applicators use as many IPM tools as possible to prolong the effective life of the new reduced-risk pesticides and to accommodate the lower efficacy of some of the 'softer' products.

The goal of this project was to determine the efficacy of promising new materials and IPM strategies that minimize pesticide use and achieve control with the least possible harm to human health, non-target organisms, and the environment. IPM approaches currently used by some growers, such as directed pesticide sprays and sticky tape, also needed to be evaluated for potential use in scouting programs. Colored sticky tapes are used both in greenhouse and field crops to reduce insect pressure by physically trapping large numbers of insects. Although these tapes may be effective in trapping insects, it has not been demonstrated if use of these tapes is sufficient in reducing insect levels within the crop.

Two novel IPM approaches that required testing for potential use in ornamental scouting programs were the use of UV absorbing greenhouse plastics and the use of metallic, reflective mulches and plant covers. Some insects use UV light for orientation during flight and UV light reflectance patterns for recognizing host plants (Kring 1972, Rossel and Wehner 1984, Scherer and Kolb, 1987, Greenough et al. 1990, Kring and Schuster 1992, Goldsmith 1993). Reflective materials and UV-blocking plastic may confuse certain pests so that they are deterred from entering greenhouses or landing on crops. Metallic materials can be placed above plants or on the ground to repel insects or camouflage plants from approaching insects.

Previous Related Work

Sampling methods for floriculture crops. Previous floriculture IPM research has focused most extensively on insect pests of two important crops, chrysanthemums (Heinz et al. 1993, Hesselein et al. 1993, Parrella et al. 1992b, Robb and Parrella 1995) and poinsettias (Ferrentino et al. 1993; Hausbeck 1995; Heinz and Parrella 1994; Parrella 1995, Parrella et al.1992a, and 1992b; Sanderson and Ferrentino 1993). Fixed precision sampling plans for thrips and mites on fresh cut roses were recently developed by Michael Parrella's lab at UC Davis, but needed to be validated. The results of these research trials have underscored the need for establishing a scouting program, and defining and refining pest action thresholds for target pest problems.

Floriculture scouting project in California. Results of research conducted by the cooperating farm advisors over the past 5 years indicate that significant cost savings and reduced pesticide use have been realized by growers participating in scouting demonstrations. Many growers involved expanded the program in their operations, and pesticide use has declined 40% or more in some cases. In sites where biological control strategies were incorporated with growers who had established scouting programs, we continued to demonstrate significant cost savings, reduced pesticide use and improved or similar crop quality (Newman et al. 1996, 1998).

Use of Petunia Indicator Plants. Some petunia cultivars have been shown to serve as good indicators of tospovirus infection (Allen and Matteoni 1991). Petunia indicator plants develop a brown or black lesion on their leaves within 2-3 days of an infectious thrips feeding. These are easy for scouts to recognize and are visible more quickly than symptoms on most crop plants. Strategically placed petunia plants indicate where to look for sources of the virus and the infectious thrips. If a source is located, its prompt removal will help reduce movement of the virus. Prior to initiating this project, there were many California growers who had problems with tospoviruses but few were aware of the use of petunias as indicator plants. Most sent their samples to commercial laboratories or relied on recognition of plant disease symptoms. By the time they did this, the disease had already spread. There are kits that can be used directly in the nursery, but growers who have used them find them too time-consuming or complicated. The advantage of using indicator plants is that the results are apparent very quickly and little technology is required for their use. Data from two trials conducted by Ullman, Robb and Newman with growers from San Diego and Santa Barbara Counties demonstrated that petunia indicators were useful in identifying the sources of infestation.

Use of reflective mulches. Numerous researchers have reported beneficial results using reflective mulches to deter population buildup of pests and virus vectors on vegetable crops (Brown et al. 1993;

Csizinsky et al. 1997; Edelstein et al.1991; Schuster and Kring, 1988). Charles Summers and James Stapleton, at the Kearney Agricultural Center in Parlier, found that the use of reflective mulches prevented insect colonization. The mulches were especially effective on Homoptera, including aphids, whiteflies, and leafhoppers, and virus incidence was greatly reduced (Stapleton and Summers, 1995,1997; Summers and Stapleton, 1998; Summers et al. 1995). Further work has been needed on ornamental crops and in coastal situations to validate that this reduced-risk management technique is effective and cost productive in commercial settings.

Use of UV-absorbing plastic films. Most greenhouse polyethylene plastic films contain ultraviolet (UV) light blocking components in order to prolong the life of the material while maintaining high levels of visible light transmission. Field studies in Israel (Antignus et al. 1996 a, b) reported significant reductions in whitefly, aphid, and thrips infestations in vegetable crops grown under UV-blocking plastic covered tunnels when compared to non-UV-blocking plastic. In Israel however, the plastic films are used in conjunction with screening, and the greenhouses are almost entirely enclosed. In contrast, many greenhouse designs in California have open walls and uncovered vents on roofs to allow natural ventilation. Previous studies conducted by Heather Costa, Entomologist at UC Riverside, showed higher immigration rate of pests into tunnels constructed of standard plastics compared to UV-absorbing plastics when given a choice, and suggested that greenhouse plastics can have a significant effect on the flight behavior of whitefly and thrips. Field studies have been needed to determine if the same benefit of pest control could be obtained in semi-open greenhouses commonly used to grow ornamental crops in California.

Materials and Methods

Use of monitoring, reduced-risk pesticides, directed spray applications, and biological control in scouting demonstration programs. **Note: this portion of the project dovetailed with the DPR-sponsored Rose Pest Management Alliance Project, as described in the Executive Summary.** A sampling plan for spider mites and thrips on fresh cut roses, developed at UC Davis, was validated at two nurseries in Nipomo and Watsonville. Subsequently, eight statewide demonstration sites implementing reduced risk pest management strategies in fresh cut roses were established.

Scouting at the demonstration sites began in early March 2000 under the supervision of cooperating farm advisors. Dr. Parrella and his lab provided statewide coordination of the project. Monitoring occurred weekly; the information was summarized and recommendations were discussed with the grower. The sampling plan for thrips used yellow sticky traps and a threshold of 25-50 thrips/trap/week. The exact threshold was tailored to reflect regional differences in growing conditions. The sampling plan for two spotted spider mites (TSSM, *Tetranychus urticae*) was based on inspecting 44 plants per 10,000 ft^2, focusing in the crown areas where mites primarily occur. A sampling plan and threshold for powdery mildew, using a predictive model based on environmental conditions and collected scouting data, was used to make fungicide recommendations for powdery mildew and botrytis.

At three nursery sites in Ventura and Santa Barbara Counties, the IPM treatment included the use of predator mites (*Phytoseiulus persimilis*, Persimilis). At the other sites, reduced-risk miticides were originally used, though towards the end of the project, almost all sites switched to the use of Persimilis in the IPM plots for TSSM control, due to grower-demand. Reduced-risk/biorational pesticides for TSSM control and compatibility with Persimilis that we evaluated were avermectin (**Avid**, Syngenta), pyridaben (**Sanmite** BASF), and bifenzate (Floramite, Uniroyal). Reduced-risk/biorational insecticides and fungicides we evaluated for other rose pests and diseases, and for compatibility with Persimilis, included insecticidal soap (**M-Pede**, Mycogen), Pymetrozine (**Endeavor**, Syngenta), Pyriproxyfen (**Distance,** Valent), neem oil (Triact and Azatin, Olympic), spinosad (**Conserve**, DowAgroSciences), fenhexamid (**Decree,** SePRO), trifloxystrobin (**Compass**, Syngenta), and azoxystrobin (**Heritage**, Zeneca).

Tospovirus monitoring. The use of monitoring stations containing petunia indicator plants and directional traps was evaluated in a commercial greenhouse in Ventura County on cut snapdragons and in a commercial greenhouse in San Diego County on potted chrysanthemums, begonia, and cyclamen. Monitoring stations were evenly spaced around the perimeter of each greenhouse complex to locate external virus sources such as weeds or landscape plantings. Within each greenhouse, monitoring stations were evenly spaced across the crops to detect virus sources within the crops. The propagation area where petunia indicator plants were grown was monitored in Ventura County to ensure that the propagation area was not a source of virus infection; in San Diego County the indicator plants were reared off-site in another facility. The seedling areas and propagation areas where the crops were produced were monitored in both counties to ensure that the crop propagation material was not a virus source.

There were a total of 21 monitoring stations in the Ventura County site and 54 in the San Diego County site. Each station had two directional yellow sticky traps (one card facing north and south, one card facing east and west) and a petunia indicator plant on a blue background to increase its attractiveness to thrips. The traps and the indicator plants were raised as needed so they remained at canopy height. Sticky traps and petunias were collected and replaced weekly. Plants and sticky cards were then shipped to UC Davis where thrips and lesions were counted. In the Ventura County site, all 18 rows of snapdragons (about 100 plants per row) in the 3600 ft^2 greenhouse were visually inspected each week for virus lesions, and the percentage of infected plants was tallied. At the beginning and end of the project, representative samples with visual virus symptoms were taken from each plot and tested by an immunoassay blot technique and by use of ELISA for tomato spotted wilt virus (TSWV) and impatiens necrotic spot virus (INSV) at UC Davis. The monitoring program was continuous over 12-16 months at each site, so trends in the presence and location of tospovirus vector sources could emerge.

Reduced risk and biorational pesticides

1. Efficacy of new reduced-risk miticides. Efficacy of reduced-risk/biorational miticides for the control TSSM was evaluated in nursery sites located in Carpinteria and Salinas.

Carpinteria Trial. Three miticides were evaluated in an 80,000 ft^2 greenhouse containing bent cane 'Kardinal' fresh cut roses. There were 16 bays within the greenhouse located on either side of a central walkway. Counts were made by randomly selecting 10 plants, uniformly distributed along the center bed in each bay. The first five-leaflet leaf above the bend in the crown area of each plant was examined, and all motile stages of TSSM were counted. In addition, one plant with mites in each bay was tagged and five leaves were examined on each of these "indicator" plants. There were four treatments: **Floramite WP, Floramite SC, Sanmite** , and an untreated control, in an RCB design. Four weekly evaluations were made after treatment. Labeled rates were used.

Salinas Trials. TSSM were collected from a commercial rose greenhouse with a history of having difficulty in controlling spider mites with conventional registered pesticides. These spider mites were suspected to be Avid-resistant. The collected spider mites were raised on a flat of young lima bean plants for about 3 weeks in a greenhouse, until sufficient quantities developed for the needs of the experiment. They were then placed on two-week old potted bean plants by aspirating 25 adult females onto a collection disk and transferring onto selected leaves. The mites were allowed to develop on the selected leaf: egg laying and nymph hatching occurred over about 2 weeks. A complete cohort of eggs, nymphs and adults existed at the time of treatment application. There were 5 replications of each treatment and the pots were laid out in an RCB experimental design in the greenhouse. Water "moats" around each experimental plant insured that mites would not move from one plant to another.

The reduced-risk pesticides evaluated in these experiments were: two insecticidal soap formulations (**RM-131** (Taogoshi Co.) and **Mpede;** cinnamaldehyde (**Cinnamite,** Mycotech);**Triact** 70; **Conserve; Floramite; (Biomite** (terpinoids, Toagosei Co.); fenpyroximate (**Acari,** SePRO); milbamectin (**GWN-1725** , Gowan). Other products with novel chemistries, but not designated as reduced-risk pesticides included: chlorfenapyr (**Pylon** , Olympic); hexythiazox (**Hexygon,** Gowan); and etoxazol (**TetraSan,** Valent). **Avid** was used as the grower standard. Treatments were applied at rates according to the manufacturers' recommendations. Spray treatments were made with pressurized hand sprayers so that the treated leaves and spider mites were thoroughly covered. There was some phytotoxicity in the first experiment so the rates were reduced in a second experiment in an attempt to reduce phytotoxicity and its potential affect on spider mite development. TSSM eggs, nymphs and adults were counted on infested leaves 3, 6, 14, 21, and 28 days after treatments were made.

2. Efficacy of fungicides for powdery mildew. Miniature roses, *Rosa x 'Fiesta Parade,'* were established in 10 cm pots in a commercial nursery. About 3 weeks before flowering, they were spaced on benches (10 plants per m^2) in an RCB experimental design with 4 replications and 2 plants per replicated treatment plot. Fungicide treatments consisted of representatives of several reduced-risk fungicidal groups: strobilurins, bicarbonate salts, horticultural oils, biocontrol agents, contact chemicals, and activated resistance compounds. A conventional sterol inhibitor fungicide was also applied for comparison. Treatments were applied at rates and intervals according to the manufacturers' recommendations. Spray volume was approximately 1400 liters per hectare (just to "runoff"). Treatments were applied with hand-held pressurized applicators.

Five days after each treatment date, powdery mildew incidence and plant vigor were rated. Powdery mildew incidence was quantified by counting the number of leaves that had at least one active mildew lesion present. Plant vigor was rated on a qualitative scale of 1 to 10 (10 was best), using plant color and vigor as the most important factors. Some treatments caused foliar necrotic lesions and edge-burn after the first application, and plant vigor ratings were appropriately downgraded.

3. Control of whiteflies on potted aster. Insecticides were evaluated on potted aster (*Callistephus chinensis* 'Mete') at a nursery in Santa Paula. Treatments were a new reduced-risk pesticide, **Distance,** and imidacloprid (**Marathon,** Olympic), a standard grower treatment, applied as a drench. Labeled rates of both products were used. Pests evaluated for control were greenhouse whitefly (*Trialeurodes vaporariorum*) and silverleaf whitefly (*Bemisia argentifolia).* There were three replications in an RCB experimental design. Three plants were evaluated in each treatment by counting all immature whitefly stages found on two randomly selected leaves. Adult whiteflies were counted on three sticky cards uniformly distributed in each plot.

UV-Absorbing plastic. We had two field sites set up in southern California to test the effects of high-UV blocking plastics on populations of whiteflies, thrips and aphids. Our site in San Diego County used a linear arrangement of hoop houses with open ends to the north and south. The Ventura County site consisted of a large greenhouse, >3.5 acres. In this greenhouse, experimental blocks were created by covering one- half of the greenhouse section (containing flowerbeds with lisianthus and lilies) with UV-absorbing plastic film. This was compared to the other half of the greenhouse section (with identical crops) grown under a standard, relatively non-absorbing plastic film. The design allowed us to compare a much larger area of covered plant material, although it was not replicated as in the San Diego experiments. We selected two plastics with similar visible light transmission spectrum that differed only in the transmission of UV light. Insect populations were monitored by standardized yellow sticky cards placed randomly at crop canopy height within each experimental block. Traps were collected, counted, and replaced weekly over a 7 month period from September 1999-March 2000, and over 18 months in San Diego. In addition to trap samples, random samples of plant material were collected weekly from leaves or flowers in each experimental block, and the number of insects counted and monitored. Mean numbers of insects captured on traps and in samples from plant material throughout the production period were compared between treatments.

Reflective mulches and plant covers. Plots with reflective mulches, reflective plant covers, and untreated controls were initiated in the summer of 1999. There were no differences between treatments. We discussed these disappointing results with Charlie Summers, who has done much of the pioneer work with reflective mulches on vegetables in California, at the Kearney Research Center in Parlier. He told us that each reflective mulch and reflective plant cover plot needs to be at least 3-rows wide to have an effect (our initial plots were only 1-row wide). We were able to repeat the trial in Ventura County, but because of the approaching winter season, the grower had to put hoop houses over our plots. This terminated the project.

We missed the early spring 2000 aster planting because the manufacturer of the overhead plant cover went bankrupt, and we were not able to obtain another supply until June (since this currently is an experimental material, and not yet in commercial use). Plots for evaluating reflective mulches and covers were established on 'Matsumoto' asters in an Oxnard nursery as soon as the material became available in early June. We evaluated five treatments: 1) reflective mulch, 2) plastic mulch with an imprinted reflective surface, 3) uncovered rows, 4) standard mulch (without the reflective surface), and 5) combination of ground mulch with the plant cover. Four replicated treated rows were laid out in an RCB design, each 30-feet long. Three adjacent rows of reflective cover were used to obtain the necessary effect. Sticky cards and plant count data was collected weekly from the center of treatments. In addition to the efficacy data, data on weed control was collected. Comparisons were made among treatments using ANOVA. Similar trials were established in San Diego County and in Santa Cruz County during the summer and early fall of 2000.

Sticky tape. The use of sticky tape was evaluated in greenhouse cut gerberas in San Diego, Ventura, and Santa Cruz Counties. Insect control was evaluated using sticky cards and plant samples, and data was collected weekly. Three sticky cards were placed equidistant along each plot. Three plant samples were examined around each card. Three leaves were examined from each plant sample from the lower, mid and upper canopy, plus a flower/terminal tap for thrips. Comparisons were made in plots with sticky tape and plots without sticky tape. There was a ≥30' barrier between each plot. Populations of leafminers, whiteflies, thrips, fungus gnats and shoreflies were compared between the two treatments. Parasitoids trapped were also counted in Santa Cruz County.

Results and Discussion

Use of monitoring, reduced-risk pesticides, directed spray applications, and biological control in scouting demonstration programs.

The IPM program was more effective than grower conventional programs for controlling TSSM (Fig 1) and thrips (Fig 2). Use of Floramite, a new reduced-risk pesticide, was effective in reducing spider mites (Fig 3). There were no adverse effects to Persimilis in plots using Conserve and Floramite. Endeavor, however, was not effective on the aphid species we encountered in some of the greenhouses, so a conventional pesticide (Diazinon) had to be used. The use of our IPM program was 2-4 times more expensive than the grower conventional treatments over-all. The use of Persimilis was not inexpensive, costing about $70 per acre per week in the Carpinteria sites where Persimilis was used in the IPM plots throughout the project. However, registered miticides such as Avid and Sanmite used in the growers' conventional programs were not as effective, and Floramite can only be used once per year. The biological control program resulted in fewer pesticide applications, increased quality, less potential hazards to workers and to the environment, and less problems with adherence to reentry requirements. For this reason, growers preferred the use of predator mites coupled with scouting to the use of conventional miticides. In fact, all growers in the demonstration sites are now using our biological control/IPM program as a standard practice.

Tospovirus monitoring. Our demonstrations showed that regardless of grower knowledge of general air-flow patterns, directional traps were necessary to determine the actual movement of thrips. In addition, petunia plants indicated that specific areas within and/or outside each greenhouse site were found to be the source of infective thrips. In the Ventura County site, the outside areas had the greatest incidence of western flower thrips (WFT) and also the greatest incidence of infective thrips. In contrast, in the San Diego site, most of the infective thrips were generated inside the greenhouses. The highest number of the infective thrips came from block ZD and block SM which were interior trapping stations, as compared to ZAEX, ZCEX, ZDEX and P blocks, which were exterior monitoring stations (Fig. 4). There was no relationship between the number of thrips and the incidence of virus at the two sites. There were times and blocks where thrips numbers were high, yet lesion numbers were low and vice-versa; there were also times and blocks where thrips numbers and lesions were both high or low concurrently. These data indicate that relying only on sticky card thrips counts for controlling tospoviruses can result in the over-use of pesticides, particularly in crops that can tolerate some thrips without visible damage.

Use of the indicator plants provided different management approaches in the two nursery sites. In the Ventura County site, because of constant thrips pressure outside, the grower made a special effort to exclude thrips through the use of internal and outer doorways with positive airflow, through on-going employee educational efforts to make sure all doors were kept closed, and through increased outside monitoring. When indicator plants had lesions, extra vigilance in weed control efforts was made outside the greenhouse. Although positive airflow was helpful in keeping outside thrips from entering the greenhouse, the outer doors were still the primary entry points for infective thrips. Our data suggest that screening or other exclusion methods to seal doorways would likely be very beneficial. Screening of vents is probably not necessary, as thrips were not found in the vent monitoring stations. The grower also used a number of techniques to keep thrips and disease pressure down inside the greenhouse, including scouting, a judicious spray program, regular weed control, and regular roguing of plants with visual symptoms of tospovirus infection.

In San Diego County where most of the lesions were generated from inside the greenhouse ranges, there was an emphasis on targeting management strategies in the affected greenhouse areas. These included the use of hydrated lime under the benches and pesticide applications within the crop to control thrips; conscientious closing of internal greenhouse doors was also important. In addition, external control measures were utilized, including closing outside doors and tightening of the greenhouses. We attribute these practices to the reduction of lesions found in the greenhouses after these treatments commenced. Use of indicator plants in the areas where crop propagation occurred resulted in cleaner planting material and avoided disastrous tospovirus epidemics at both nursery sites.

Reduced-risk and biorational pesticides

1. Efficacy of new reduced-risk miticides.

Carpinteria Trial. Even though the **Floramite WP** contained the highest initial populations of TSSM over-all, there was complete control after the first week that was maintained throughout the monitoring period (Fig 5). The **Floramite SC** formulation was not as effective. However, it reduced the TSSM population 66% after the first week, and by the third week TSSM was 100% controlled. In contrast, the **Sanmite** was less effective than the control. Although after the first week there was over a 50% reduction, by the fourth week the population had doubled from the pre-treatment level. In the control plots, a contamination of the predator mite *Phytoseiulus persimilis* developed that decimated the

TSSM populations in those plots. A similar contamination was observed in the Sanmite treatment. However, these mites did not thrive, presumably because the Sanmite was toxic to them. Similar trends were found in the indicator plant data.

Salinas Trials. The most effective miticides evaluated on nymphs (Table 1) were **Triact, Hexygon, GWN-1725, Acari, Floramite, TetraSan, and Biomite. Avid** only provided good control at 10 times the labeled rate (3.1 ml/l). Similar trends were found on other life stages.

2. *Efficacy of fungicides for powdery mildew.* The Strobulurins (**Compass, Heritage, Cygnus**) had the best control on powdery mildew as a group without causing loss of vigor (Table 2). They were most effective at the shorter intervals (weekly for Heritage and Cygnus, every 14 days for Compass). Many other products were moderately effective but caused mild to severe loss in vigor due to phytotoxicity.

3. *Control of whiteflies on potted asters.* **Distance** maintained good control for the 26 days we examined data on leaf samples (Table 3). From this data, Distance was superior to the standard treatment; we saw a similar trend in the sticky card data. Whitefly populations were initially very high in both treatments, and declined both as a result of the treatments and plant tissue death due to aging.

UV-absorbing plastic. In the studies conducted in San Diego County, the number of thrips captured on sticky cards, and on plant samples were lower in greenhouses constructed of high UV-blocking plastic compared to standard plastic (Fig.6). Similar results were found on aphids. In contrast, there was no difference in numbers of greenhouse whitefly *(Trialeurodes vaporariorum)* captured on sticky cards or counted in plant samples. In previous studies (Costa and Robb 1999), when we tested these materials on greenhouse whitefly and western flower thrips in small, completely enclosed tunnels, we saw dramatic differences in the numbers of insects captured under each type of plastic. The addition of unfiltered sunlight into the system through the open ends may have eliminated differences among treatments in terms of attractiveness to whiteflies.

In Ventura County, there was no difference between the two greenhouse plastic films on greenhouse whitefly (the major pest) population levels, or on other pests present in lower numbers. Again, this is probably the result of the greenhouse having open sides and uncovered vents in the roof that allowed unfiltered sunlight to enter the ranges at intervals throughout the house.

Reflective mulches and plant covers. Our work with metallic, reflective plant covers in asters in all sites indicates that these materials were especially effective in reducing numbers of thrips. Populations of aphids and whiteflies were also reduced. However, the plastic mulch with imprinted reflective surface was no more effective than the controls.

Our results in Oxnard show that mulches protected the crop initially, but this effectiveness over the control was lost later in the crop cycle as crop canopy covered the mulch. When metallic mulches and plant cover (netting) were used in combination, results were better than when either was used alone (Figure 7). It is likely that as plants mature and the canopy covers the ground mulch, overhead covers become more important. In our set up in Oxnard we were not able to move the overhead reflective net as the crop matures. In San Diego and Santa Cruz Counties, growers were able to do this by attaching the netting to the overhead support grid. Data from these sites show that the same results as the combination treatment could be achieved by raising the plant cover as the crop matures. This may reduce the over-all cost of the treatment. However, the combination treatment used in Oxnard significantly reduced weeds, due to the ground mulch, and this provided an added economic benefit not realized with the overhead crop covers alone.

This research must be conducted on additional crops to demonstrate to growers that the benefits of the reflective materials outweigh the additional costs of material and labor in these crops. Cost of ground mulches are only about $140 per acre, and can easily be offset by reduced pesticide application costs. Reflective plant covers cost $290 per acre, and are more labor intensive, so further economic studies are needed to determine feasibility.

Sticky tape. Our data show that whiteflies in the crop (fig 8), as well as whiteflies on traps, were lower in plots using sticky tape. In Ventura County, there were statistical differences in number of immature whiteflies founds in the plots with sticky tape, based on Fisher's least significance difference (LSD) test for mean separation. In contrast, the only significant difference in the Watsonville nursery (Table 4) was the number of adult whiteflies on plants in the sticky tape plots. Thrips populations were not high enough to document significant difference. There were no significant effects on leafminers, other pests, or parasitoids. There were no discernable quality differences in the crops produced with or without tape. Although sticky tape is fairly inexpensive (about $.03/linear ft for 6"-wide sticky tape), this practice may not be economically justifiable for gerberas, when adding in the extra labor for installing and changing the tape.

Summary and Conclusions

Demonstrations were set up in eight site locations for incorporating reduced-risk pesticides with biological control. This portion of the project is funded by the DPR-sponsored Rose Pest Management Alliance project, and will continue through March 2001, when the project results will be described in much further detail. The demonstration has been tremendously successful with all cooperating growers who switched from their conventional practices to our IPM program.

Demonstrations were also set up in two site locations in San Diego County and in Ventura County to evaluate the use of petunia indicator plants and directional traps for tospovirus monitoring. Results show that petunia plants are a useful scouting tool and that petunia indicator plants were useful to cooperating growers in determining where the source of thrips vectors were originating from so that they could adjust their pest management programs accordingly.

New IPM approaches that reduce pest populations, including reduced-risk/ biorational pesticides, UV-absorbing plastic for greenhouse coverings, reflective mulches and plant covers, and sticky tape were also evaluated. In the evaluation of new reduced-risk pesticides, Distance was effective in reducing whiteflies in asters. Numerous reduced-risk and biorational miticides and fungicides for potential use on roses were identified.

Use of non-reflective, UV-absorbing plastic as a greenhouse cover can be effective, but efficacy was limited in passively-cooled greenhouses. Use of reflective screens may make this technology of use to growers who are primarily using passively-cooled greenhouses.

Reflective mulches and reflective plant covers were effective in reducing aphid, whitefly, and especially thrips populations. For seasonal control, reflective plant covers are most effective if they are mounted so that they can be raised as the crop matures, keeping the cover just above the canopy. Reflective mulches also controlled weeds. Use of sticky tape reduced immature whiteflies within the plant canopy of greenhouse cut gerberas, though no differences in crop quality were observed.

Educational programs were an integral part of this proposal and a key to the success of adoption of IPM programs on a large scale. Dissemination of information occurred through written articles, field days and workshops. Project activities to extend information from this project included training for those interested in IPM programs through regional IPM pest and disease seminars offered through CORF, an educational organization for the California flower and nursery industry. There were four IPM seminars that reached about 225 growers and other industry participants statewide. In addition to the regional scouting training program, there were two grower tours at CORF statewide meetings. These tours to see demonstration sites utilizing reflective mulches, UV-absorbing plastic, reduced-risk pesticides, and biological control took place in October 1999 and June 2000 with a total of 230 participants. Meetings to coordinate the development of these programs were held September 1999, October 1999, and September 2000. Meetings for rose growers to extend information from the rose demonstration sites took place in February, April, and July 2000. There were approximately 65 participants at these meetings. In addition, there were numerous conference calls between the investigators to plan and coordinate educational activities.

Seventeen articles were developed for newsletters, trade journals and scientific publications (see list of publications). Impact of the project was measured through records of numbers of growers reached in demonstrations and workshops, through meeting evaluations, and talking to participants. Grower feedback indicated that these training meetings have been highly useful in increasing adoption and understanding of IPM practices.

As a result of the demonstrations and extension of information learned from this project there has been an increased use of reduced- risk/biorational pesticides, lower over-all pesticide use, increased use of predator mites for biological control, and increased use of petunia indicator plants.

Cited References

Allen, W.R. and J.A. Matteoni. 1991. Petunia as an indicator plant for use by growers to monitor for thrips carrying the tomato spotted wilt virus in greenhouses. Plant Disease 75:78-82.

Antignus, Y., M. Lapidot, N. Mor, R. Ben-Joseph, S. Cohen. 1996a UV-absorbing plastic sheets impair the epidemics of insect vectored virus diseases. Proceedings of the XX International Congress of Entomology, Firenze, Italy, August 25-31, 1996.

Antignus, Y., M. Lapidot, N. Mor, R. Ben-Joseph, S. Cohen. 1996b. Ultra violet absorbing plastic sheets protect crops from insect pests and virus diseases vectored by insects. Environmental Entomology 25: 919-924.

Brown, J.E., J.M. Dangler, F.M. Woods, M.C. Henshaw, W.A. Griffy, and M.W. West. 1993. Delay in mosaic virus and aphid vector reductions in summer squash grown on reflective mulches. HortScience 28:895-896.

Costa, H. S., and K. L. Robb. 1999. Effects of ultraviolet-absorbing greenhouse plastic films on flight behavior of *Bemisia argentifolii* (Homptera: Aleyrodidae) and Frankliniella occidentalis (Thysanoptera: Thripidae). J. Econ. Entomol. 92: 557-562.

Csizinszky, A.A., D.J. Shuster, and J.B. Kring. 1997. Evaluation of color mulches and oil sprays for Yield and the control of silverleaf whitefly, *Bemisia argentifolii* on tomatoes. Crop Prot 16:475-481.

Ferrentino, G., J. Grant, M. Heinmiller, J. Sanderson and M. Daughtery. 1993. IPM for poinsettias in New York: a scouting pest management guide. New York Sate IPM Program Publ 403. Cornell University, Ithaca, NY 47 pp.

Edelstein, M. H.S. Paris, R.Shir, G, Beibowits, H. Nerson, and Y. Burger. 1991. Effects of reflective plastic mulch on fall-grown summer squash. Hassadeh 71:868-869.

Goldsmith, T. H. 1993. Ultraviolet receptors and color vision: evolutionary implication and a dissonance of paradigms. Vision Res. 34: 1479-1487.

Greenough, D. R., L. L. Black, and W. P. Bond 1990. Aluminum-surfaced mulch: an approach to the control of tomato spotted wilt virus in solanaceous crops. Plant Disease 74: 805-808.

Hausbeck, M. 1995. Managing powdery mildew on poinsettia, pp. 7-11. In A. Bishop, M. Hausbeck, and R. Lindquist [eds.] Proc. Eleventh Conference on Insect and Disease Management on Ornamentals, Fort Myers, FL, 150 pp.

Heinz, K.M., L. Nunney, and M.P. Parrella. 1993. Toward predictable biological control of *Liriomyza trifolii* (Diptera: Agromyzidae) infesting greenhouse cut chrysanthemums. Environ. Entomol. 22: 1217-1233.

Heinz, K. M., and M.P. Parrella. 1994. Biological control of *Bemisia argentifolii* (Homoptera: Aleyrodidae) infesting *Euphorbia pulcherrima*: Evaluations of releases of *Encarsia luteola* (Hymenoptera: Aphelinidae) and *Delphastus pusillus* (Coleoptera: Coccinellidae). Environ. Entomol. 23:1345-1353.

Hesselein, C., K. Robb, J. Newman, R. Evans, and M. Parrella. 1993. Demonstration/IPM Program for Potted Chrysanthemums in California. IOBC/WPRS Bulletin 16: 71-76.

Kring, J. B. 1972. Flight Behavior of Aphids. Annual Review of Entomology 17: 461-492.

Kring, J. B. and D. J. Schuster. 1992. Management of insects on pepper and tomato with UV reflective mulches. Florida Entomologist 75: 119-129.

Newman, J., S. Tjosvold, K. Robb, and A. King. 1996 Implementation of IPM scouting programs for ornamental crop production. IOBC/WPRS Bulletin 19(1):111-113.

Newman, J., K. Robb, S. Tjosvold, A. King. 1998. How to set up a scouting program on ornamental crops. CORF IPM Workshop Publication. 13 pp.

Parrella, M.P. 1995. IPM - Approaches and prospects, pp. 357-363. In B.L. Parker, M. Skinner, and T. Lewis [eds.] Thrips Biology and Management. NATO-ASI Series. Series A: Life Sciences Volume 276. Plenum Press, New York.

Parrella, M.P., T.S. Bellows, R.J. Gill, J.K. Brown, and K.M. Heinz. 1992a. Sweetpotato whitefly: prospects for biological control. Calif. Agriculture 46:25-26.

Parrella, M.P., K.M. Heinz, and L. Nunney. 1992b. Biological control through augmentative releases of natural enemies: A strategy whose time has come. Amer. Entomol. Fall 1992: 172-179.

Parrella, M.P., Murphy, B. , D. von Damm-Kattari, G von Damm-Kattari, C. Casey. 1999. Better pest management with directed sprays. GrowerTalks. January. 92, 94-5.

Robb, K.L., and M.P. Parrella. 1995. IPM of western flower thrips, pp. 365-370. In B.L. Parker, M. Skinner, and T. Lewis [eds.] Thrips Biology and Management. NATO-ASI Series. Series A: Life Sciences Volume 276. Plenum Press, New York.

Rossel, S. and R. Wehner. 1984. Celestial orientation in bees: the use of spectral cues. Journal of Comparative Physiology A. 155: 605-613.

Sanderson, J.P., and G.W. Ferrentino. 1993. Basic IPM: Whiteflies on poinsettias, pp. 1-14. In Robb and Hall, [eds.] Proc. Ninth Conference on Insect and Disease Management on Ornamentals, Del Mar, CA 111 pp.

Scherer, C and G. Kolb. 1987. Behavioral experiments on the visual processing of color stimuli in *Pieris brassicae* L. (Lepidoptera). Journal of Comparative Physiology A, 160: 647-656.

Schuster, D.J. and J.B. Kring. 1988. Management of insects of tomato with UV-reflective mulches pp 5-19. In Report of tomato research 1987-88. Univ. of Florida, Gainesville, FL.

Stapleton, J.J. and C.G. Summers. 1995. Reflective mulches repel aphids and protect Cucurbitaceous crops from virus diseases. UC Plant Prot. Quart. 5(1):4-6.

Stapleton, J.J. and C.G. Summers. 1997. Reflective mulch for managing aphids, aphid-borne viruses and silverleaf whitefly:1996 season review. UC Plant Prot. Quart. 7(1):1-15.

Summers, C.G. and J.J. Stapleton. 1998. UC Plant Protection Quarterly. 8(1&2): 9-11.

Summers, C.G. and J.J. Stapleton, A.S. Newton, R.A. Duncan, D.Hart. 1995. Comparison of sprayable and film mulches in delaying the onset of aphid-transmitted virus diseases in Zucchini squash. Plant Dis. 79:1126-1131.

List of Abbreviations

List of Abbreviations

INSV= Impatiens necrotic wilt virus

RCB= randomized complete block

TSSM= two spotted spider mite

TSWV= tomato spotted wilt virus

WFT= western flower thrips

List of Publications Produced

Costa, H., K. Robb, C. Wilen, J.Newman. 2000. Field trials measuring the effects of ultra-violet blocking greenhouse plastic films on populations of whiteflies, thrips, and aphids. In: Proceedings for the 18th Annual CORF Grower Tour and Research Demonstrations, Ventura County, June 22, 2000. Ukiah, CA. 27 pp.

Costa, H. S., K. Robb and C. Wilen. 2000. Increased persistence of *Beauveria bassiana* spore viability under high ultraviolet-blocking greenhouse plastic. pp 127-129. *In*: M. S. Hoddle, (Ed.). Proceedings of the Second Annual California Conference on Biological Control. July 11-12, 2000. Riverside, CA.

Hilje, L., H. Costa and P. A. Stansly. 2000. Cultural practices for managing whiteflies. Abstracts of International Congress of Entomology. (Foz do Iguassu- Brazil) Embrapa Soja, Londrina, PR, Brazil.

Newman, J. 2000. Reflective mulches on field grown asters: Help for Thrips and Aphids? CORF News 4(4):9.

Newman, J. 2000. CORF tour visits PMA site. CORF News 4(3):9.

Newman, J. 2001. The recent evolution of IPM programs. GMPro. ***In press.***

Robb, K. 2000. Tospovirus and western flower thrips—thoughts on control. CORF News 4(3):7.

Robb, K, C. Casey, A. Whitfield, L. Campbell, J. Newman, and D. Ullman. 1999. Using Petunia indicator plants to monitor tospoviruses in ornamental plants. American Floral Endowment. 4pp.

Newman, J. New research project to evaluate reduced-risk pesticides and practices. 1999. CORF News: 3(3):7.

Newman, J. Evaluation of reduced risk pesticides. 2000. CORF News: 4(1):10-11.

Newman, J. and S. Martin. 2000. Use of reflective mulches on field-grown asters in Ventura County. In: Proceedings for the 18th Annual CORF Grower Tour and Research Demonstrations, Ventura County, June 22, 2000. Ukiah, CA. 27 pp.

Newman, J., S.Tjosvold, S. Martin, L.Bolkan, C.Casey, D. Haasl, J.MacDonald, M. Parrella, K. Robb ,and J. Rodgers. 2000. Development of an integrated pest management program for greenhouse cut roses at two demonstration sites in Ventura and Santa Barbara Counties. In: Proceedings for the 18th Annual CORF Grower Tour and Research Demonstrations, Ventura County, June 22, 2000. Ukiah, CA. 27 pp.

Robb, K. Evaluation of UV-absorbing plastic films for insect control. 1999. Using petunia indicator plants to monitor tospoviruses in ornamental plants. CORF News: 3(2):5.

Robb, K. C.Casey, A. Whitfield, L. Campbell, J. Newman, D. Ullman. 1999. Using petunia indicator plants to monitor tospoviruses in ornamental plants. CORF News: 3(2):1,9.

Robb, K., H. Costa, J. Bethke, R. Cowles, M. Parrella.. 2000. UC IPM Pest Management Guidelines: Floriculture and Ornamental Nurseries. Insects and mites. pp. B 1-37. UC DANR Publication, Oakland CA. (Available on Web http://www.ipm.ucdavis.edu).

Tjosvold, S. 2000 Evaluation of reduced risk and other biorational pesticides on the control of spider mites (*Tetranychus urticae*). CORF News: 4(2):6.

Tjosvold, S. 2000. Minimum reentry fungicide trial. CORF News: 4(3):6.

Appendices of Tables and Figures

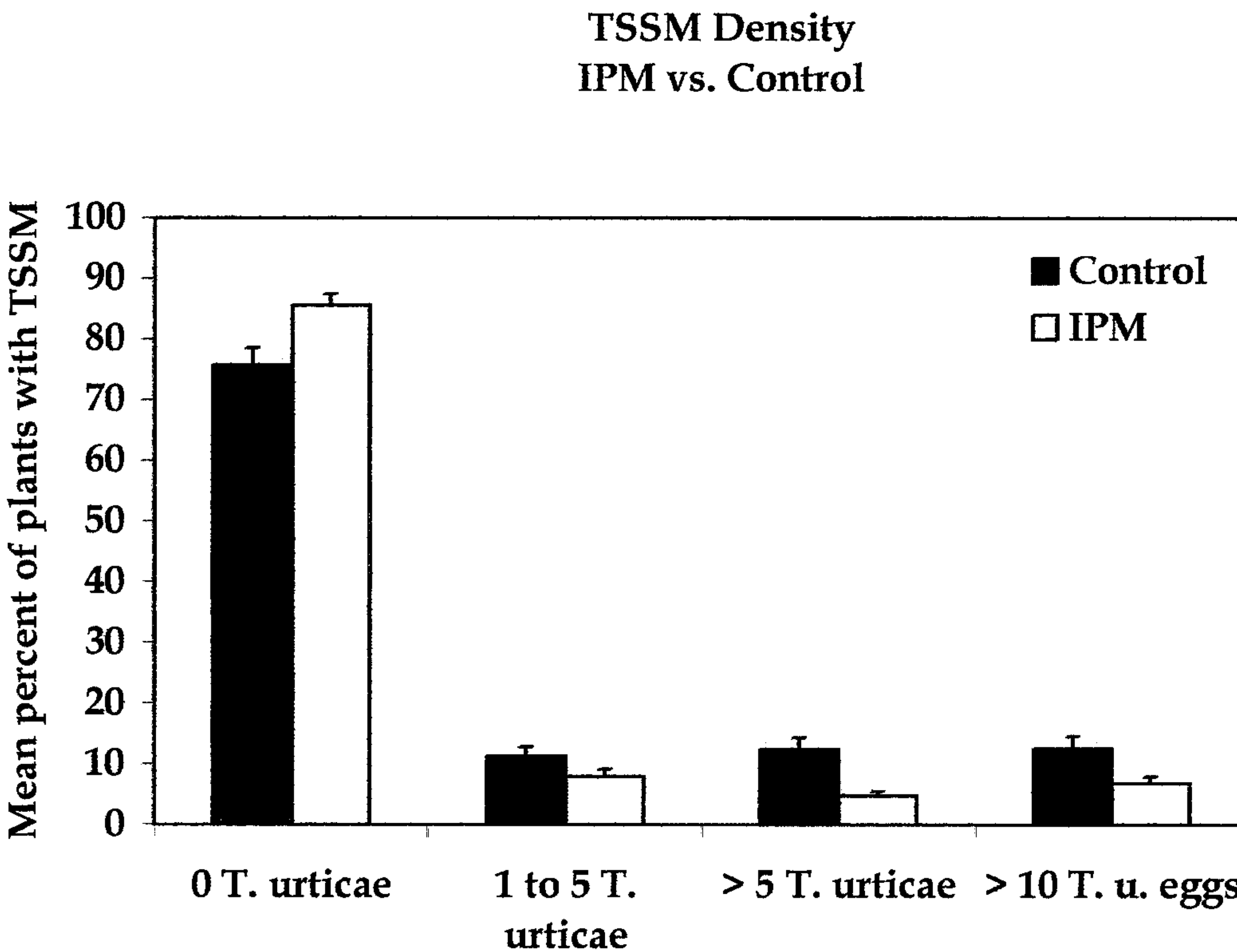

Fig 1. An IPM program was more effective for control of TSSM than grower conventional programs. The IPM program used scouting, reduced- risk pesticides, and directed spray applications. Use of predator mites was used in the IPM program in some sites. Data is from plots in 8 nurseries over 10 months.

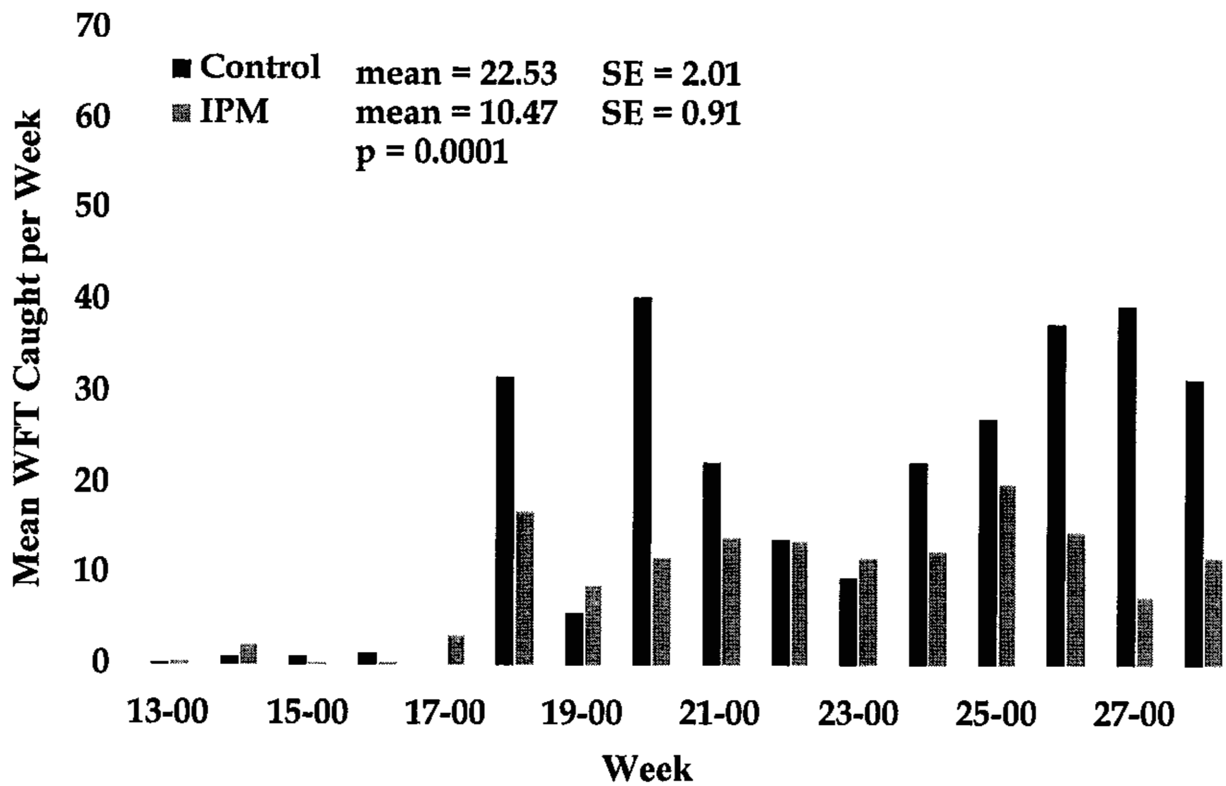

Fig 2. Mean number of western flower thrips (WFT) trapped on sticky cards per week in IPM plots at four nursery sites compared to WFT trapped in control plots.

Efficacy of Floramite on Twospotted Spider Mites

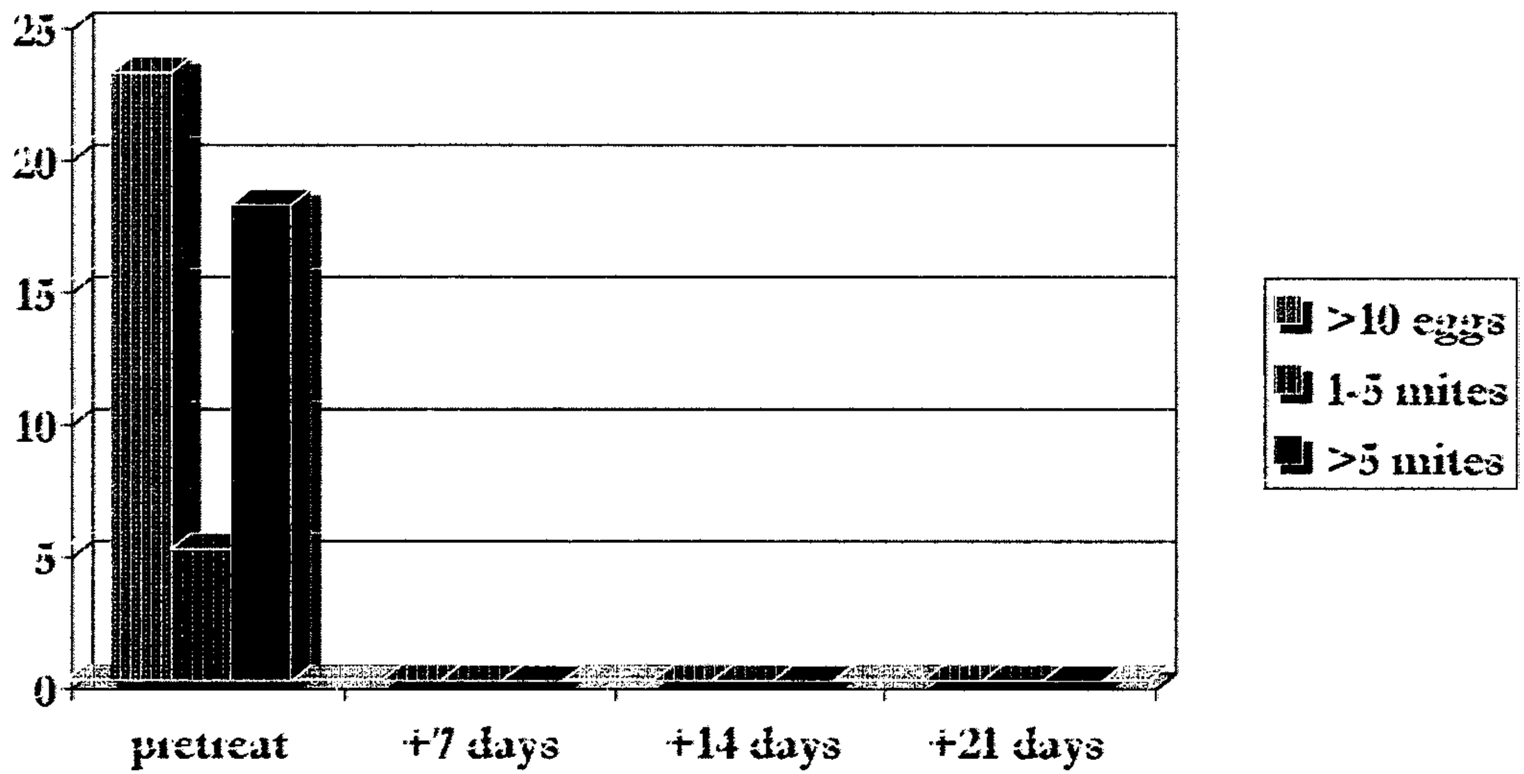

Figure 3. Effect of Floramite, a new reduced-risk pesticide in a San Diego County demonstration site for TSSM control on cut roses.

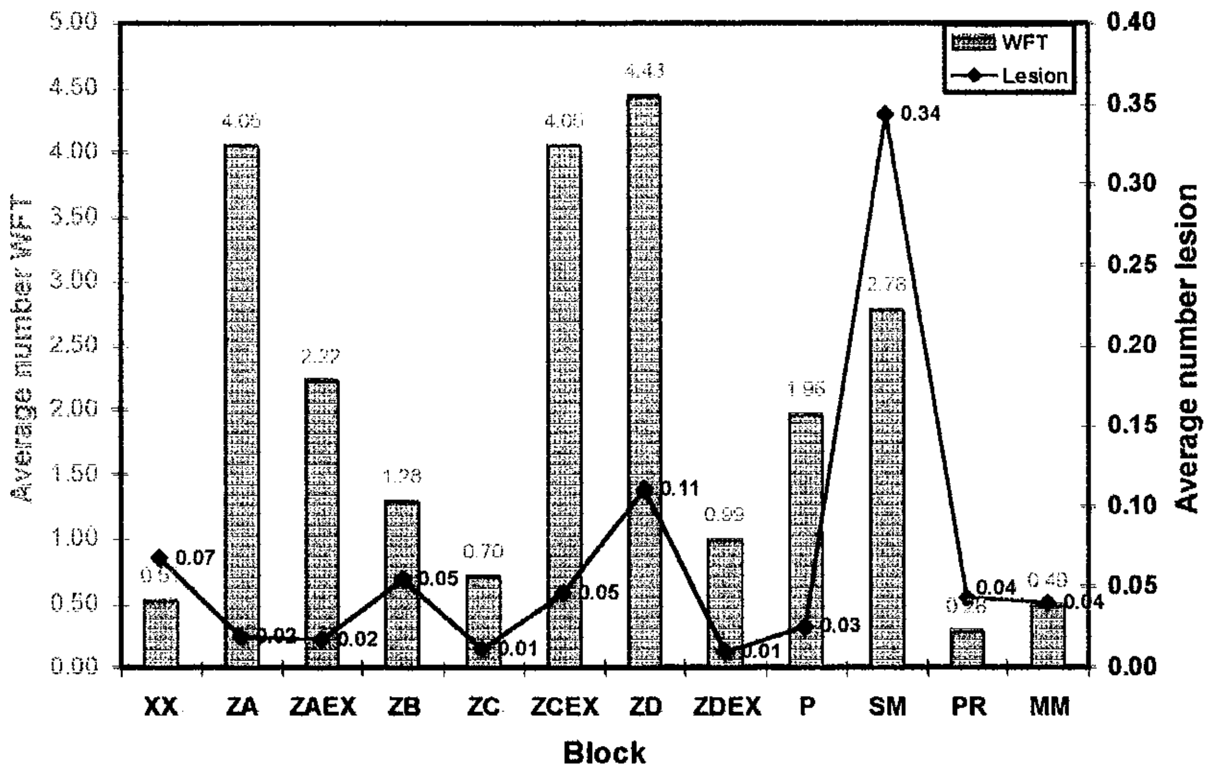

Fig 4. Number of WFT and lesions on petunia indicator plants by blocks in a San Diego County nursery over a 17 month period.

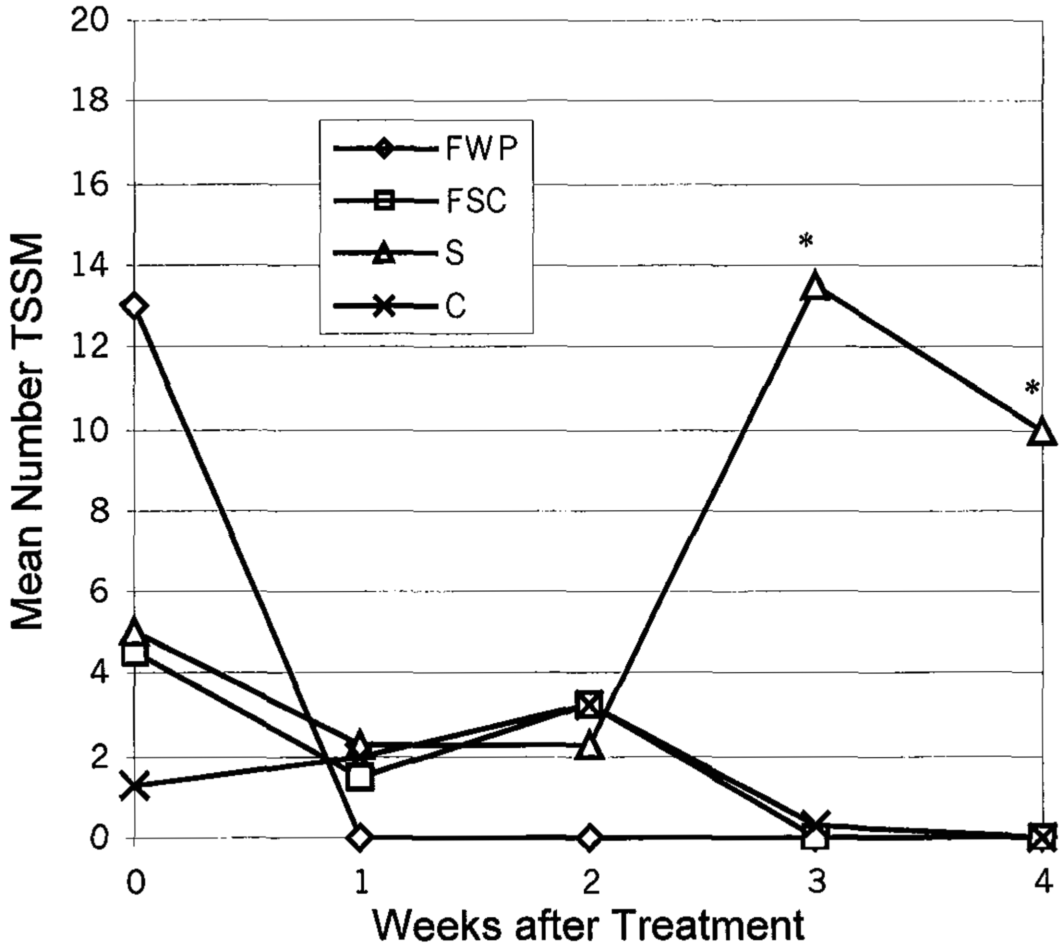

Figure 5. Effect of miticides on TSSM populations on plant samples in cut roses. There were 4 replicated blocks of 10 plant samples collected uniformly down the center row of each block. Asterisks (*) indicate a significant difference between Sanmite and other treatments based on Fisher's least significance difference (LSD) for mean separation.

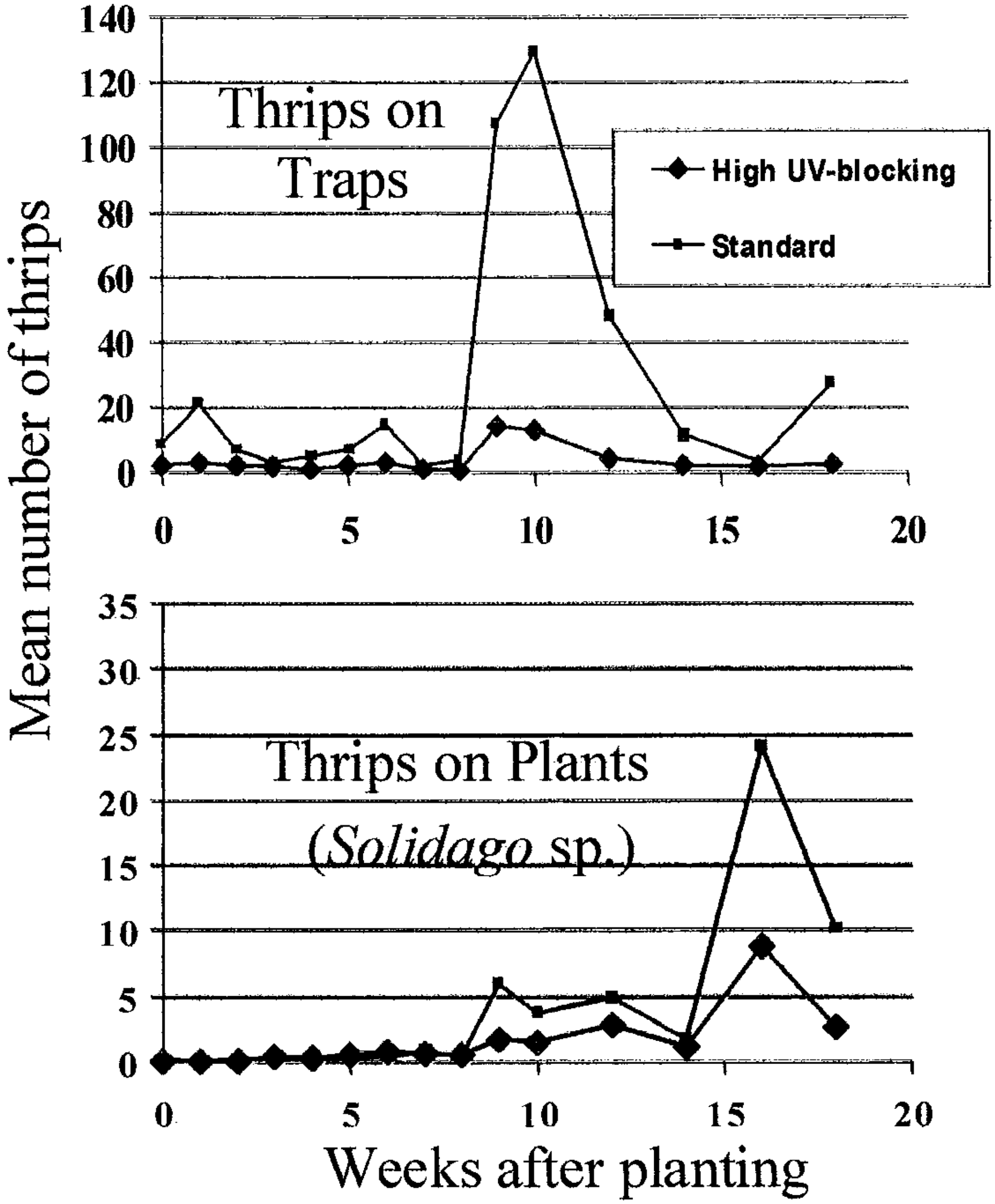

Figure 6. Mean number of thrips captured on yellow sticky traps, or counted on *Solidago* plants, under standard (<360 nm) or high UV-blocking (<380 nm) greenhouse plastics.

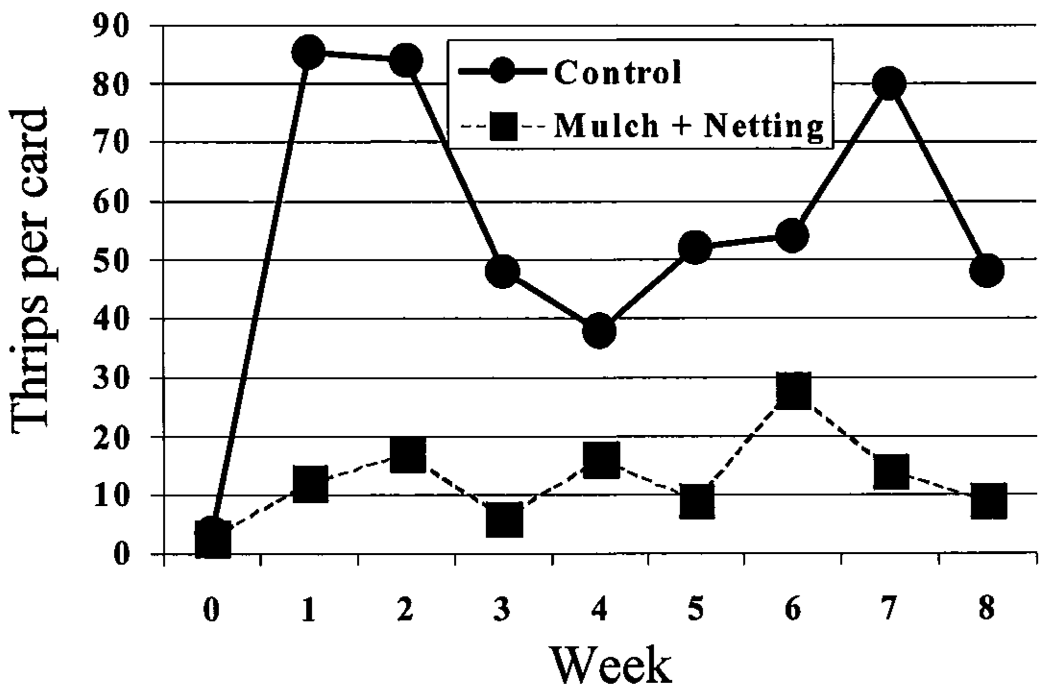

Figure 7. The effect of reflective mulch and plant covers (netting) on thrips in asters in Oxnard, CA. When metallic mulches and netting were used in combination, results were better than when either was used alone. It is likely that as the plants mature and the canopy covers the ground mulch, overhead covers become more important.

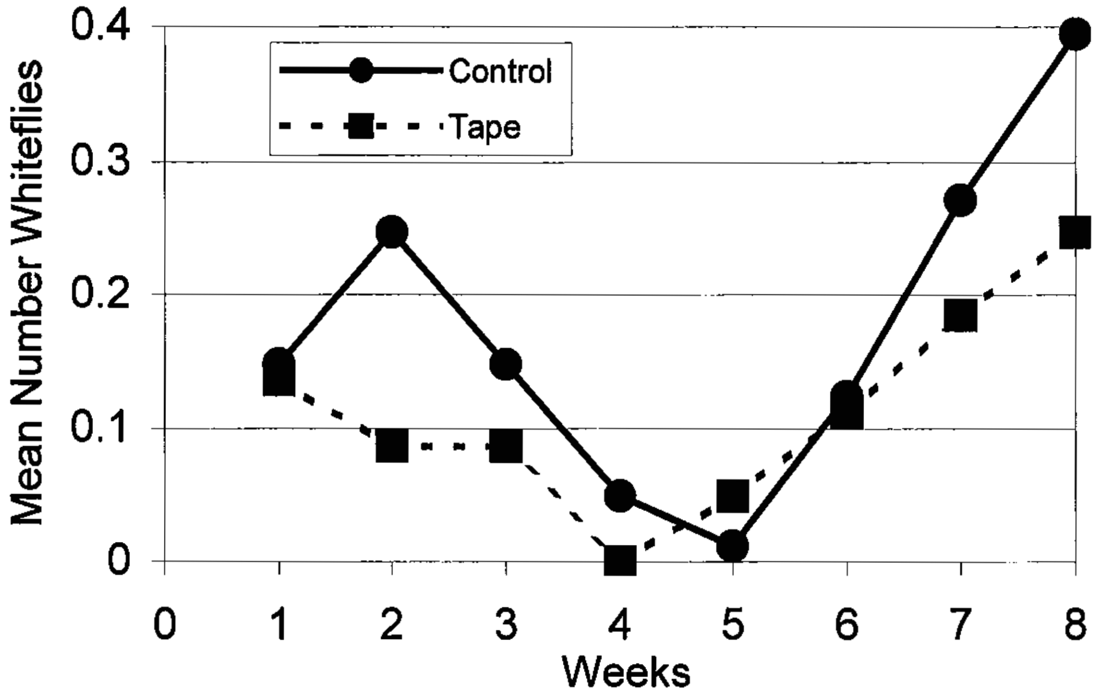

Figure 8. Effect of yellow sticky tape on immature whitefly populations on leaf samples in gerberas in an Oxnard nursery.

Table 1. Effect of Miticides on *Tetranychus urticae* Nymphs

Formulated Treatment	Active Ingredient	Formulated Rate/liter	Trial #1 Overall	Trial #2 Overall
Untreated Check	water		25.5 hij	32.1 gh
Avid 0.15 EC	abamectin	0.31 ml	10.6 fg	
Avid 0.15 EC	abamectin	3.1 ml		4.4 ab
Pylon 2 SC	chorfenapyr	0.19 ml	27.0 ij	14.3 d
Mpede	salt of fatty acids	1%	34.7 j	18.6 f
Cinnamite 30 LC	cinnamaldehyde	6.65 ml	14.6 gh	37.1 h
Triact 70 EC	Neem oil	1.00%	2.0 abcd	4.9 ab
Hexygon 50 WP	hexythiazox	0.08 g	2.3 bcd	7.7 c
Hexygon 50 WP	hexythiazox	0.15 g	1.8 abc	7.9 c
GWN-1725 1% EC	milbamectin	0.63 ml	1.2 ab	3.9 a
GWN-1725 1% EC	milbamectin	1.25 ml	0.8 a	4.9 ab
Acari 5%SC	fenpyroximate	0.94 ml	6.0 ef	8.9 cd
Acari 5%SC	fenpyroximate	1.88 ml	3.5 cde	6.4 bc
Conserve 1 SC	spinosyn	0.86 ml + 0.1% Adjuvant	13.8 gh	17.7
Conserve 1 SC	spinosyn	1.72 ml + 0.1% Adjuvant	5.4 ef	20.3 fg
Floramite 50 WP	bifenzate	0.15 g	5.0 e	4.6 ab
Floramite 50 WP	bifenzate	0.30 g	3.3 cde	3.3 a
TetraSan 5 WD	etoxazole	1.08 g	1.8 abc	6.5 bc
Biomite	terpinoids	3.70 ml	4.1 de	
Biomite	terpinoids	5.90 ml	1.9 abcd	
Biomite	terpinoids	1.85 ml		3.9 a
Biomite	terpinoids	2.50 ml		6.3 bc
RM-131A 70EC	fatty acid glycol ester	3.51 ml + 0.1% Adjuvant	28.1 ij	
RM-131A 70EC	fatty acid glycol ester	7.01 ml + 0.1% Adjuvant	17.8 ghi	
RM-131B 70EC	fatty acid glycol ester	1.00 ml		29.9 fgh
RM-131B 70EC	fatty acid glycol ester	1.50 ml		41.7 h

Means followed by the same letter are not statistically differently. LSD p,.05

Adjuvant= Nofoam B, CMR, Fresno CA

Table 2. Effect of Fungicides on Powdery Mildew and Plant Vigor in Rosa x hybrida 'Fiesta Parade' *Mean over all dates*

Formulated Treatment	Active Ingredient	Frequency of Application	Formulated Rate/liter	Powdery Mildew		Vigor	
Check	water + adjuvant	every 7 days		16.0	k	9.2	abc
Terraguard	triflumazole	every 14 days	0.60 g	5.6	efg	9.2	ab
A1584 DF	proprietary	every 14 days	1.20 g	5.3	efg	9.4	a
E-RASE	jojoba oil	every 7 days	2.50 ml	4.8	cdefg	7.2	fghi
E-RASE	jojoba oil	as needed	5.00 ml	4.7	cdefg	8.1	def
Compass	benzeneacetic acid	every 14 days	0.15 g	2.7	abcde	5.2	klm
Compass	benzeneacetic acid	every 28 days	0.15 g	3.4	bcdef	5.9	ijkl
Heritage	azoxystrobin	every 7 days	0.07 g	1.6	ab	9.3	a
Heritage	azoxystrobin	every 14 days	0.15 g	5.1	defg	8.6	abcde
Cygnus	kresoximethyl	every 7 days	0.12 g	3.7	bcdef	9.1	abcd
Cygnus	kresoximethyl	every 14 days	0.24 g	4.3	cdefg	9.1	abcd
SP5001	gama aminobutyric acid, glutamic acid	every 7 days	0.30 g	15.1	jk	8.7	abcde
SP5001 + Cygnus	gama aminobutyric+ kresoxymethyl	every 7 days	0.30 g + 0.12 g	3.2	bcdef	8.3	bcdef
Elexa	chitosan, copper and zinc gluconate	every 7 days	0.1% v/v	3.8	bcdefg	7.3	fgh
Elexa +MKP	chit. Etc. + Monopotassium phosphate	every 7 days	0.1% + 1% v/v	2.2	abc	7.6	efg
BAS14UBF	Reynoutria sachalinensis extract	every 7 days	0.5% v/v	3.7	bcdef	5.5	jklm
BAS14UBF	Reynoutria sachalinensis extract	every 7 days	1.0% v/v	2.4	abcd	4.6	lm
Kaligreen	potassium bicarbonate	2 weekly apps then wait 14 days	3.6 g	1.0	a	6.7	ghij
Kaligreen rotate Heritage	potassium bicarbonate / azoxystrobin	2 weekly apps then wait 14 days	3.6 g	2.8	abcde	7.7	efg
Armicarb	potassium bicarbonate .	2 weekly apps then wait 14 days	3.00 g	5.5	efg	6.3	hijk
Armicarb rotate Heritage	potassium bicarbonate / azoxystrobin	2 weekly apps then wait 14 days	6.00 g	3.8	bcdefg	5.0	klm
AQ-10	Ampelomyces quisiqualis	every 7 days	0.08 g	12.2	jk	8.2	cdef
AQ-10	Ampelomyces quisiqualis	every 7 days	0.15 g	10.9	ijk	8.0	ef
QRD713 AS	Bacillus subtilis	every 7 days	1.0% v/v	7.1	ghi	7.5	fgh
QRD713 AS	Bacillus subtilis	every 14 days	1.0% v/v	14.7	jk	7.7	efg
Topshield	Trichoderma harzianum	every 14 days	7.50 g	10.0	hij	7.4	fgh
ZeroTol	hydrogen dioxide	every 7 days	9.78 ml	6.3	fgh	5.3	jklm
Cinnamite	cinnamaldehyde	every 7 days	6.65 ml	2.7	abcde	4.3	m

Treatments applied 9/02/99, 9/09/99, and 9/16/99 when appropriate. Powdery mildew and vigor rated approximately 5 days after each treatment date. Powdery mildew rating is the mean number of leaves with at least one mildew lesion on two plants (lower rating = better mildew control). Vigor rating factors leaf color, plant vigor, and phytotoxicity (higher the rating = better plant vigor) Ratings followed by the same letter are not statistically different. LSD, $p<0.05$

Table 3. Mean Number of whiteflies on sticky cards in Aster potted plant plots with Distance, a new reduced-risk pesticide, as compared to the grower's conventional treatment (Marathon). There were 3 sticky cards uniformly distributed in each plot and three replications per treatment.

Date	Distance Mean Whitefly Counts Per Plant	Standard Mean Whitefly Counts Per Plant
3/24	16.7	23.7
3/31 (5 d post-spray)	5.7	14
4/7	3.7	7
4/14	.33	4.7
4/21	1.3	4.3

Table 4. Mean number of whiteflies per sticky card and per plant on greenhouse cut gerberas in beds with and without sticky tape in a Watsonville nursery. There were three replications with a different cultivar in each randomized complete block ('Lilabella,' 'Grizzly' and 'South Pac'). Means in a column followed by a different letter are significantly different. Mean separation by 95% LSD. All other column means are not significant by ANOVA.

	Sticky cards	Adults on plants	Immatures on plants
Tape	343.7	11.3 A	3.1
No Tape	420.6	31.3 B	6.3